COAL

By

Mary K. Chapin

EWING GALLOWAY

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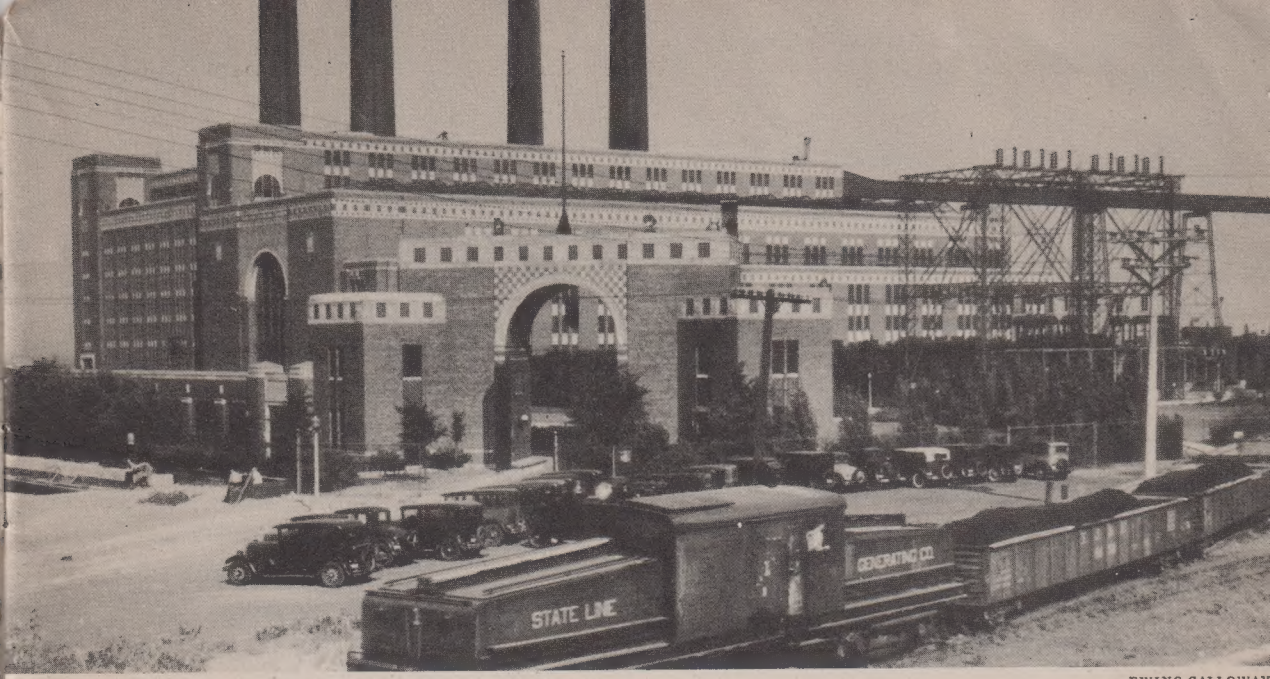
U. S. DEPARTMENT OF INTERIOR

A seam of coal



EWING GALLOWAY

A great power plant run by coal

• COAL •

CAN you guess this riddle?

There is something that ordinary householders store away in their cellars by the ton. Yet it is worth more than all the world's gold and silver. Poor people can buy it—and great nations fight for it. Terrible explosives—and healing medicines—are made from it. It may be the source of ill-smelling gases—or of delicious perfumes. Much of it is rocklike—but it burns.

The answer, of course, is *coal.*

What Kinds of Coal Are There?

"As black as coal," we say, but some coal is brown, not black. Coal is not all alike.

Does your stove or furnace burn hard or soft coal? Then, no doubt, you know something about one of the many different kinds of coal.

Soft coal—its long name is "bituminous coal"—is not really soft; it is merely not so hard as hard coal. It is black and rather dusty. It

breaks into flat-sided blocks. Usually it burns with a bright-yellow, smoky flame. In a good stove or furnace a soft-coal fire should not give off unpleasant odors and should not "smoke up" the curtains or walls. If it does either of these things, the fire is not getting enough air, and coal is being wasted (because it is not being completely burned).

Hard coal, or anthracite—at least, the best of it—is shiny and rather clean. It breaks into pieces with sides a little curved. It burns with pretty flames, short and blue, not very bright, and almost smokeless and odorless. Housewives like anthracite, for it is easy to keep a house clean where hard coal is burned.

You may have an open fireplace in which big chunks of cannel coal are burned. Cannel coal is dull black, and almost as clean to handle as hard coal. It burns with a very hot, bright-yellow flame. You can light some cannel coal with a match, as you would a candle. In fact, the name "cannel" came from "candle." "Cannel coal" is really "candle coal."

Brown coal, or lignite, is usually brown but sometimes almost black. It has a woody grain. The name "lignite" comes from a word meaning "wood." Much lignite is soft and moist when fresh, and cracks to pieces or crumbles to powder when dry. Brown coal gives out less heat in burning than the black coals do.

Peat being dug from the ground

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Peat is a kind of "unfinished" coal which gives off even less heat in burning than brown coal. It is brown, very soft, and so moist that it must be dried before it is good to burn. Yet, because it is found at the top of the ground and is easily cut, it is much used for heating houses in some parts of Europe. It is a poor man's fuel.

What we call jet is really a very hard kind of coal. It is used for making buttons, beads, and other ornaments, and not for fuel.

There are many different kinds of both hard and soft coal. Hard coal, soft coal, brown coal, and cannel coal, however, are the main kinds for you to remember. Hard coal and soft coal are far more important than the other kinds.

The Uses of Coal

What is coal good for? "To keep the house warm in winter," you may say. "To cook the meals, too," perhaps you add.

True, much coal is used in homes for heating and cooking. Yet more than three times as much coal is used in other ways. What does that matter to you? A great deal.

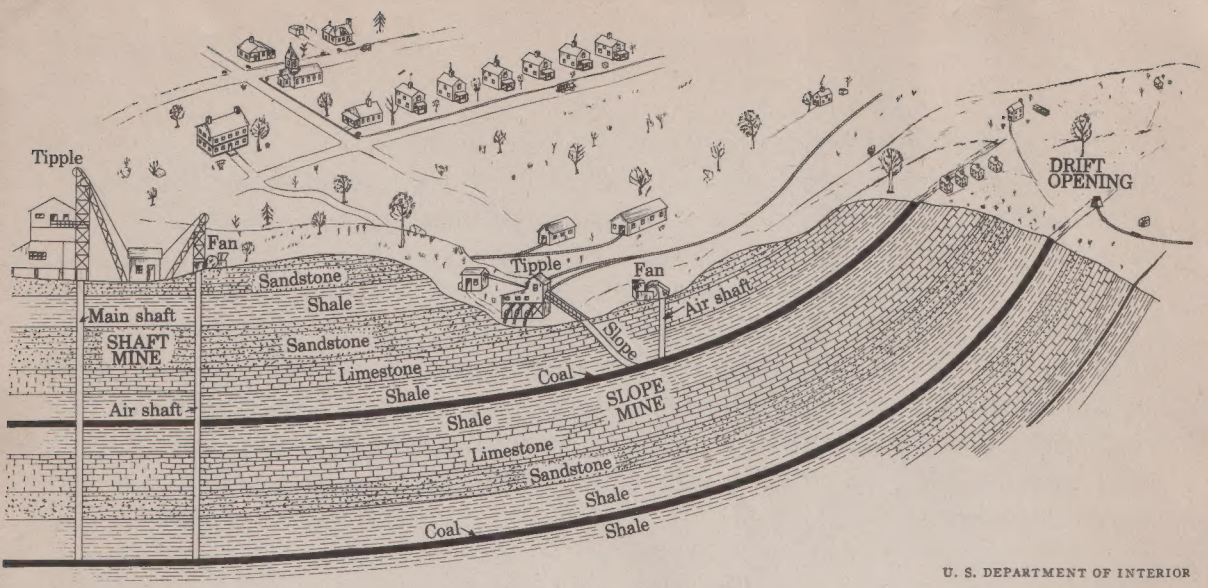
Do you go about town by electric streetcar? Probably the electric current comes from a coal-burning steam power plant.

On your breakfast table may be oranges from Florida or California, butter from Wisconsin, and bread made of wheat grown in Kansas or Nebraska. How did they reach you? They were probably brought on freight trains pulled by coal-burning locomotives.

Your clothes are made of cloth woven, probably, on looms driven by steam—and the steam is made with coal fires.

In fact, if you knew the story of the things that you use and see daily, you would find that most of them had been either made or brought to you, or both, by the aid of coal. In our modern world machines are our servants and coal is the "food" which most of our machine servants must have in order to work.

Many great cities are near great coal fields. It is not hard to understand why. The coal is one reason the cities are great. They have grown great partly by manufacturing. Manufacturing has grown great there partly because of the cheap fuel, coal, that can be had near by.



Getting Coal from the Ground

Coal is found in the earth in beds, or layers. In some parts of the earth layers of coal—some of them perhaps less than an inch thick, and others many feet thick—are piled up as in a layer cake, with layers of different rocks as "filling" between.

In some places a crumpling of the earth's crust has so broken and tilted the coal beds that their bare edges stick up out of the ground. There it is easy to break off all the exposed coal to carry away. When the surface coal is gone, it is not hard to follow up a tilted coal seam by digging a "slope" mine. A coal seam standing out on a hillside may not be tilted. It may be followed up by digging a "drift" mine into the side of the hill.

In some places coal lies so near the surface that the easiest way to get it is to shovel off the earth above before digging the coal. This kind of mining is "strip" mining. In modern strip mines great electric or steam shovels first remove the earth. Then smaller power shovels scoop up the coal.

Much of the easily mined coal was used up long ago. Today most of our coal comes from "shaft" or "pit" mines, perhaps one or two hundred feet deep, perhaps deeper still. A mine in Belgium is nearly three-

quarters of a mile deep. Of course, it does not pay to dig a very deep mine except to reach thick coal beds.

A shaft or pit mine is somewhat like a giant anthill. A central shaft reaches down to a coal bed. The miners must cut long passages, like the runways in an anthill, from the bottom of the shaft hundreds of feet through the coal. In the anthill, however, the galleries, or tunnels, run in many directions, up and down as well as sidewise. In the coal mine the galleries follow the coal bed and can run no farther up or down than the coal.

In an anthill a central shaft as large around as a lead pencil may lead into a nest spreading over several square feet. Just so, a coal shaft measuring fifteen by thirty feet or less at the top may be the gateway to an underground city spreading over several acres. One mine in this country has an underground spread of about ten square miles.

How do the miners find their way about in their man-made anthill into which no sunbeam ever enters? Why does the huge weight of the earth above the underground city not settle on it and crush it? Let us go and see. We shall have to charter an imaginary airplane, for we are going to travel far in a short time!

Strip mining

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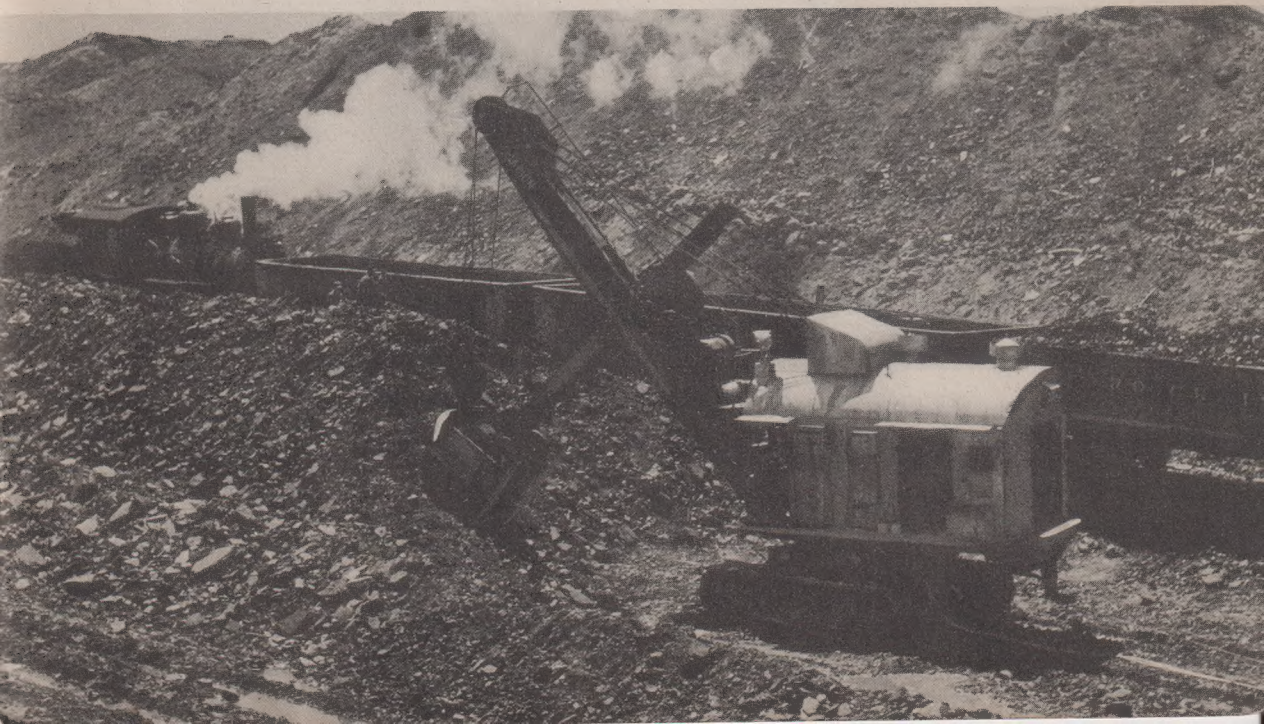

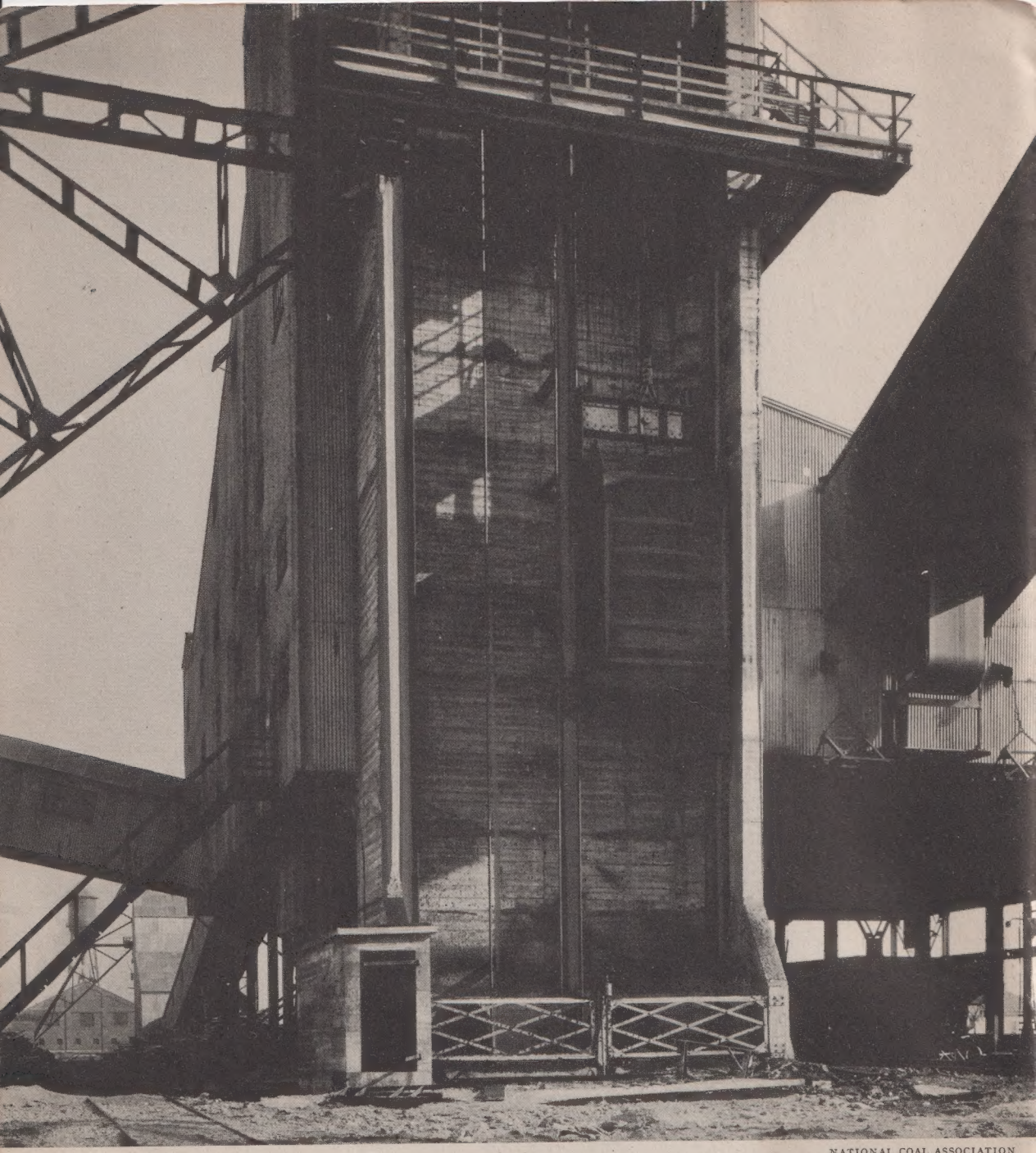

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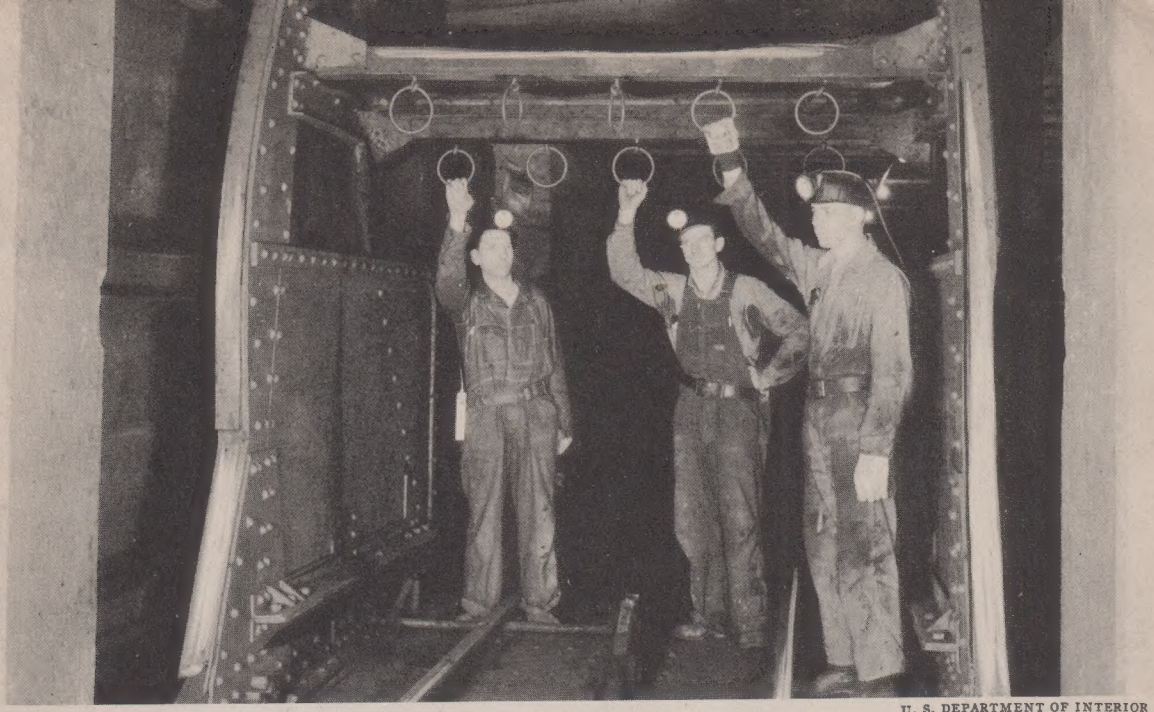
Main shaft and skip of a soft-coal mine



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A cage

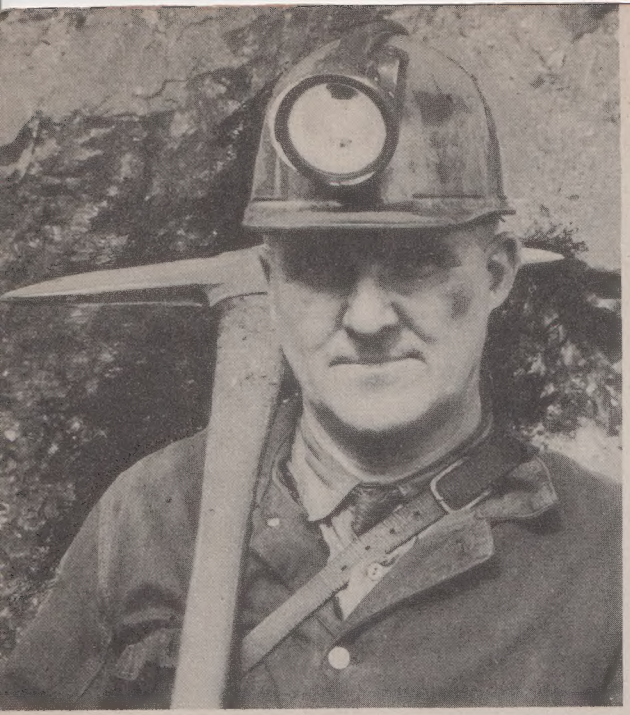
A Journey Through the Land of Coal

First our plane sets us down near the entrance to a great soft-coal mine in the Middle West. We are in a little village of large, oddly shaped buildings with a large railroad yard. On the tracks are many open cars, some empty, some loaded with coal.

The tall building near which we landed is called the "tipple." We shall learn later about the work done in it. Right now we are interested to learn that it covers the entrance to the mine. In it are what we should call the elevator shafts. A huge bucket, bringing up several tons of coal at a time, serves as a kind of dumb-waiter. The miners call it the "skip." A passenger elevator carries the miners down the shaft to their work and brings them up again. The miners call it the "cage."

Close by the tipple is the "hoist house." This building houses the machinery that lifts and lowers the cage and the skip.

We get permission to see the mine. A guide takes us to the shaft. We enter the cage, along with several miners. Down we drop into the darkness.



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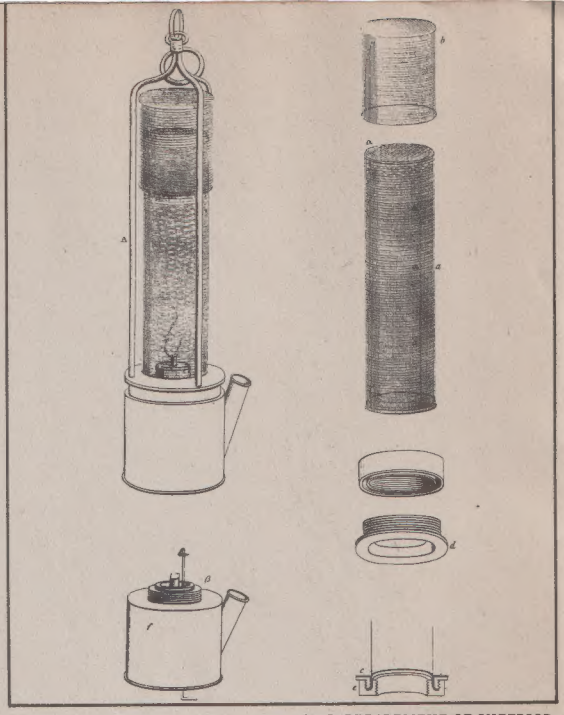
A hard-coal miner



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A Davy safety lamp

The miners, we notice, wear little electric lights on their odd helmet-shaped hats. When we reach the bottom of the shaft, we see lines of electric lights stretching away into the darkness.

Our guide tells us that electric lights are the only kind allowed in this or any other modern mine. Why? There are dangerous gases, or "damps," in the coal. "Choke-damp" smothers, "white-damp" poisons, and "fire-damp" explodes at the touch of a flame or a spark. In this mine a ventilating system sweeps the dangerous gases out and draws fresh air in. Yet it will not do to take the chance that any open flame might happen to meet fire-damp somewhere.

Long ago, before electric lights were invented, miners had to work by the open flames of candles or lamps. Every now and then many miners were killed by terrible explosions.

Then the great English scientist, Sir Humphrey Davy, found that flame will not pass through a fine wire screen or gauze. He then made one of the world's great life-saving inventions; he invented the famous Davy safety lamp. No one knows how many miners' lives that lamp has saved.

While most mines are now lighted entirely by electric safety lamps, the Davy lamp is still used to test for the presence of fire-damp. Though flames cannot pass out through the wire gauze, gas can pass in. If fire-damp is present, the color of the flame in the Davy lamp changes to blue. That change in color says, "Take care! Danger!"

There is a railroad in this underground city. A car stands near. Our guide tells us to get in. After a ride of about a mile, we come to a room where miners are at work. They are not using hand picks and shovels, as all miners once did. In a great modern mine like this one machines run by electricity do almost everything. The miners merely guide the machines.

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An undercutting machine at work

An undercutting machine is cutting a long, deep gash in the wall of coal just above the floor. Farther on is a miner drilling holes with an electric drill in a wall of coal already undercut.

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Drilling holes with an electric drill

Later, when all the men except the blasters are out of the mine, explosives will be placed in the holes and fired off. Then the whole wall above the undercut will come tumbling down in chunks.

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Getting ready to blast

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A loading machine

Loading machines will load the broken coal on mine cars. The cars will carry the coal to the skip. There a rotary dump will turn the cars over, thus unloading the coal. Then the skip will raise the coal to the surface.

An engine pushing cars of coal to the skip

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A rotary dump

We too must go back to the surface. First we ask our guide about the timbers we see. Do they keep the mine roof from falling down on the miners' heads? "No," he says, "the timbers overhead merely help to keep loose pieces of rock and coal from falling down." (The hard, light helmets the miners wear often save them from being hurt by such falling rock or coal.) Huge posts or pillars of coal twenty or thirty feet thick have been left to hold up the roof until the rooms are "worked out" and the miners are ready to leave that part of the mine and let the roof fall.

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The coal can never be entirely taken out. About half of it is usually left in the mine.

Some of the important work of the mine is done aboveground. Much of it is done in the tipple, into which the coal goes from the skip.

In the tipple the coal is cleaned, partly by hand, partly by machinery. The pieces of slate and rock mixed with the coal are taken out and thrown on piles of refuse we noticed when we first came. Next the different sizes of coal are sorted out. Then the coal is loaded on cars. The cars are weighed and inspected.

Now the coal is ready to start on its journey to do the world's work. We too are ready to begin our journey again. We are going eastward to see a hard-coal mine.

On our way we pause for a moment by the entrance to a drift mine on a beautiful mountainside. Here we see many loaded cars of cleaned and sorted soft coal awaiting shipment.

The breaker of a hard-coal mine

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Sorting coal

The anthracite mine where we next alight is a shaft mine, too. While there are many differences among shaft mines, much of what we see at this hard-coal mine is very like what we have already seen at the western soft-coal mine.

Here the tall building where the coal is cleaned and sorted is called the "breaker" instead of the "tipple." Hard coal must be broken, cleaned, and sorted. From the bottom of the breaker a conveyer runs to the top of a high bank. Refuse from the coal is carried through the conveyer up the bank. That black hill we see beyond the bank was not made by Nature. It is the dump or "culm bank" where the coal refuse is thrown.

Before we end this imaginary journey of ours, we pause again by an eastern riverside. Here we see a great fleet of loaded coal barges. The cheapest way to ship coal is by water; so a coal mine that can reach its customers by water has a great advantage.

Now perhaps you would like to know what coal really is and how it happens to be stored away in the earth's coal cellar waiting for us to take it out and use it.

FIELD MUSEUM OF NATURAL HISTORY

A forest of the Great Coal Age

How Coal Was Formed

Let us take another imaginary journey, this time back through the ages—millions and millions of years back to the Great Coal Age. There have been a number of little coal ages, but most of the world's best coal was formed in the Great Coal Age.

In the Great Coal Age there were no people on earth. There were no animals that fed their babies on mother's milk. There were no birds. In the sea, however, there were fishes. On the land there were little lizard-like animals, huge spiders, and giant insects such as six-inch cockroaches and dragonflies with wings nearly a yard across.

The air was warm and moist. Much of the land was swampy forest. The forest trees were not oaks or maples or pines or any other trees that we know. They were mostly huge ferns, great mosses, and giant horsetails. They grew fast. They died and fell into the water. More trees grew.

Under the water the dead trees did not rot as they would in the open air. Thick layers of dead plant material grew thicker year by year. They formed peat much like the peat which even today forms under water in swampy forests and other swampy lands.

In the coal ages some of the forest land was slowly sinking. Many forests sank into the sea. There they became covered with sand and mud. Then slowly the land rose again. Once more forests grew on it. In some places this happened many times.

Ages passed. Great changes came about—too many changes even to name here. Mountains became plains, and plains became mountains. Sea beds became dry land, and dry land became sea beds. Great ice sheets spread down from the North. Some of the mud and sand over the buried forests hardened into rock. In some places the weight of ice was added to the weight of rock over the layers of plant material.

That weight grew very great. The pressure squeezed the layers of plant material. It drove out some of the water. Other changes took place in the plant material. In time it became coal. In some places it became lignite or brown coal. In other places longer time and greater pressure made bituminous or soft coal. In still other but fewer places very great and long-continued pressure made anthracite or hard coal.

Cannel coal is believed to have been formed from different plant materials, perhaps under somewhat different conditions. Fern spores are among the important materials of cannel coal. (Fern spores are the tiny, brown, dustlike particles you may have seen on the underside of fern leaves. They serve the ferns as seeds.) Algae, or seaweeds, are found in cannel coal, too.

As has been said, there was no human being on earth during the Great Coal Age. Then how do we know all this? The coal itself kept the record—the coal and the rocks between the coal layers! In the coal itself there are prints of leaves, stems, tree trunks, and even of the giant cockroaches and dragonflies of the Great Coal Age. In the rocks between the coal layers there are fossils of the fishes that swam above the drowned forests.

A tree trunk in a bed of coal

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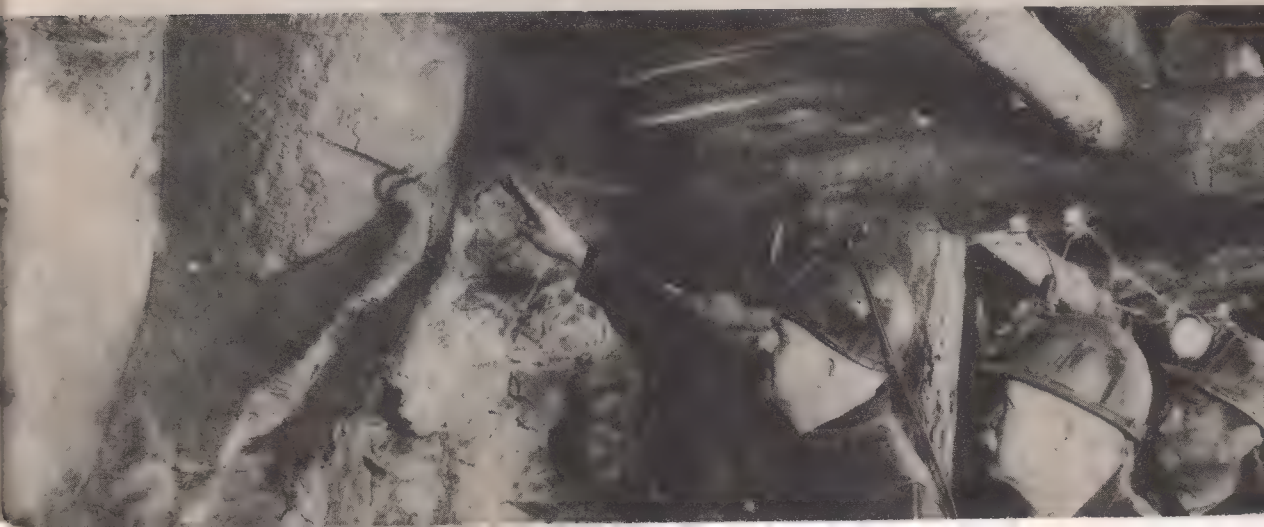


What Coal Has Done for Men

Coal has given men and nations riches and power, but not until very late in the world's story. For thousands of years men did not use coal at all. They did not know how to use it.

How did they get along without it? Why did it take them so long to learn how to use it? How did they happen at last to make use of it? Let us see.

Men got along without coal very simply. They did without many things that we today think we have to have.

They did without comfort in cold weather. In winter people shivered on one side and roasted on the other before the blazing logs of the fireplace—if they were lucky enough to have either fireplace or blazing logs. Wood was scarce and costly in many places. Poor people often could not afford it.

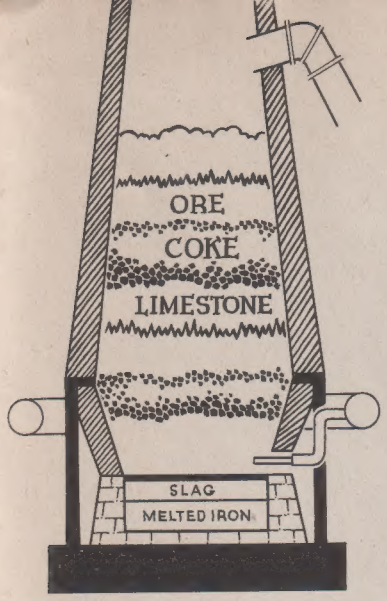
Many Europeans did not even know that coal would burn. Two hundred years or so before Columbus discovered America an Italian merchant named Marco Polo traveled into unknown China. He brought back many strange tales. One that the people at home found very hard to believe was that the Chinese made good fires of black rocks!

Of course, it is not quite so easy to burn coal as to burn wood. Hard coal is especially hard to set on fire. Soft coal may give off ill-smelling gases if burned in open fires — and stoves and furnaces were long unknown. In very early times chimneys were not in common use even in castles and palaces.

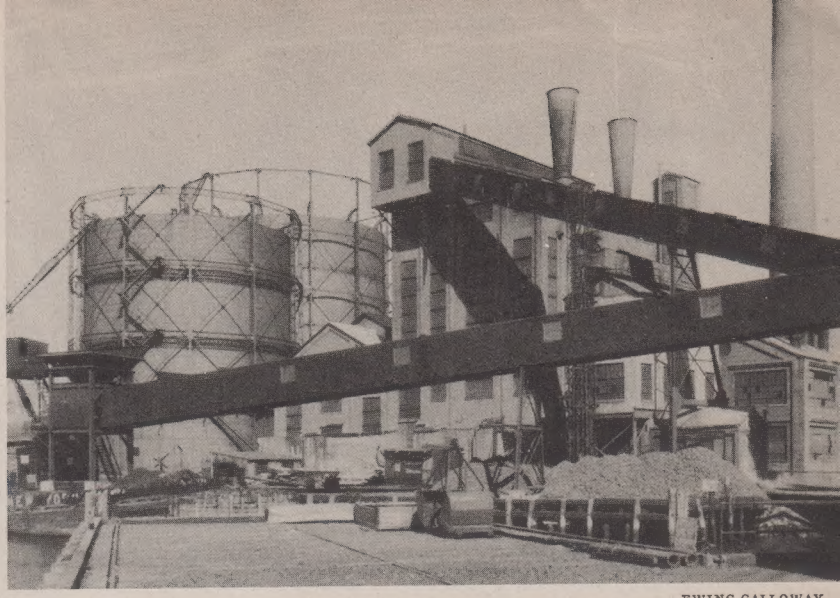
Then, little by little, people found out how to use coal to keep warm, and even to bake bread and cook dinner. They had to use it when wood grew scarce and expensive.

People still had no steel pens, much less any typewriters. Women treasured steel needles and had no sewing machines. Farmers reaped their grain and mowed their hay by hand. As for locomotives and automobiles and airplanes, if any such things could have been seen then they would have passed for sheer magic.

Yes, you say, but what has all this to do with coal? It has everything to do with coal. If it were not for coal, you and I would still be writing with quill pens. We would wear no clothes sewed by machines or made



A blast furnace



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A plant for manufacturing coal gas

of cloth woven by machines. We would eat no bread made by machines. We would never go riding in the machines called automobiles. Why?

Most machines are made mostly of iron and steel. There is plenty of iron in the earth. It is in the earth in the form of iron ore. Before the iron can be used it must be freed from the other materials in the ore by the use of heat and carbon. Heat and carbon are needed, also, to make steel out of iron. Coal and wood charcoal are made up mostly of carbon.

Freeing iron from the ore is called "smelting." It was a great day in the history of mankind when some man first found out how to smelt iron from the ore by the use of wood charcoal. It was another great day when another man found out how to make steel out of iron, also by using wood charcoal.

It takes a great deal of wood charcoal to smelt iron out of the ore, and to make steel out of iron. Therefore, in old times iron and steel were scarce and costly. An iron pick was a treasure.

In those days no one dreamed of inventing big iron or steel machines. What would have been the use? The iron and steel to make a sewing machine or a reaper would have been worth a small fortune. That for a locomotive would have cost a king's ransom.

When the forests that supplied wood charcoal were almost used up, iron and steel grew still dearer and scarcer. Could coal dug up from the earth be used instead of wood charcoal for smelting iron and making steel? It did not seem so. Gases are driven off from coal when it is burned. These gases ruin iron and steel.

Then someone had a wonderful idea. Charcoal is made by roasting wood in airtight ovens. Why not try roasting coal in airtight ovens also? Perhaps the roasted coal could be used instead of charcoal for smelting iron and making steel.

"Cooked" coal or "coke" was made. It was tried first in the smelting of iron and later in the manufacture of steel. It took time to find out how to use coke for these purposes, but finally it was a great success.

Now for the first time it was possible to make iron and steel cheaply and in great quantities. Now it was possible to make iron and steel machines, too—and even to make them in great numbers. Inventors began to invent hundreds and hundreds of machines. Thus the Machine Age began when men began to understand how to use coal to make iron and steel!

Roasting the coal to make coke drives off the substances in the coal that spoil iron and steel. Some of these wastes are driven off in the form of gases, others in the form of gummy coal-tar liquids. Getting rid of these wastes used to be a great nuisance. The gases escaped into the air and killed the grass and trees and flowers. The coal tar ran off into the streams and poisoned the fish.

A large coke plant

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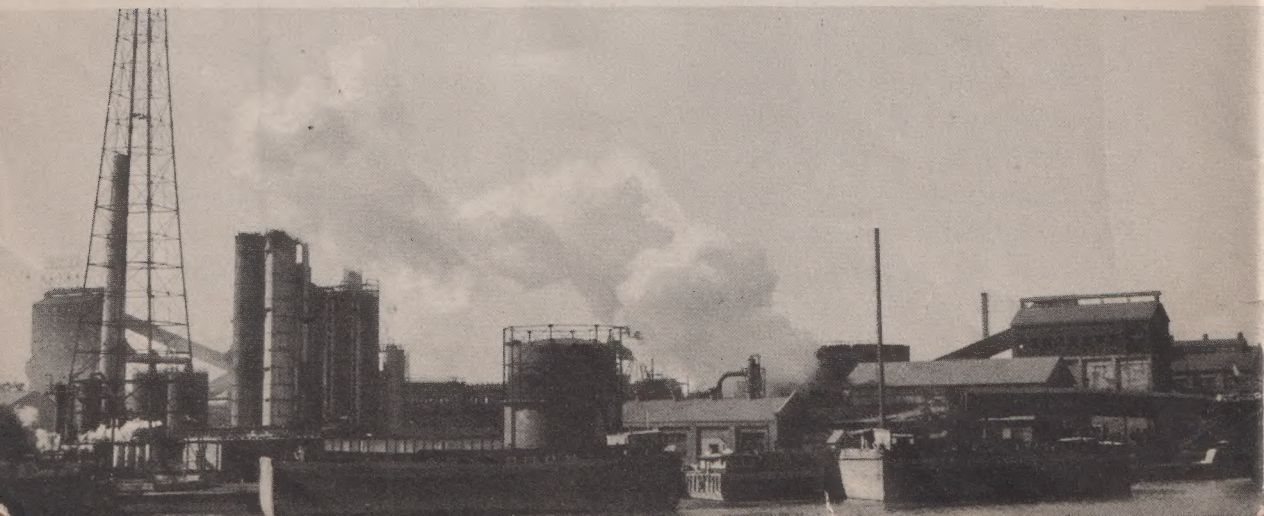

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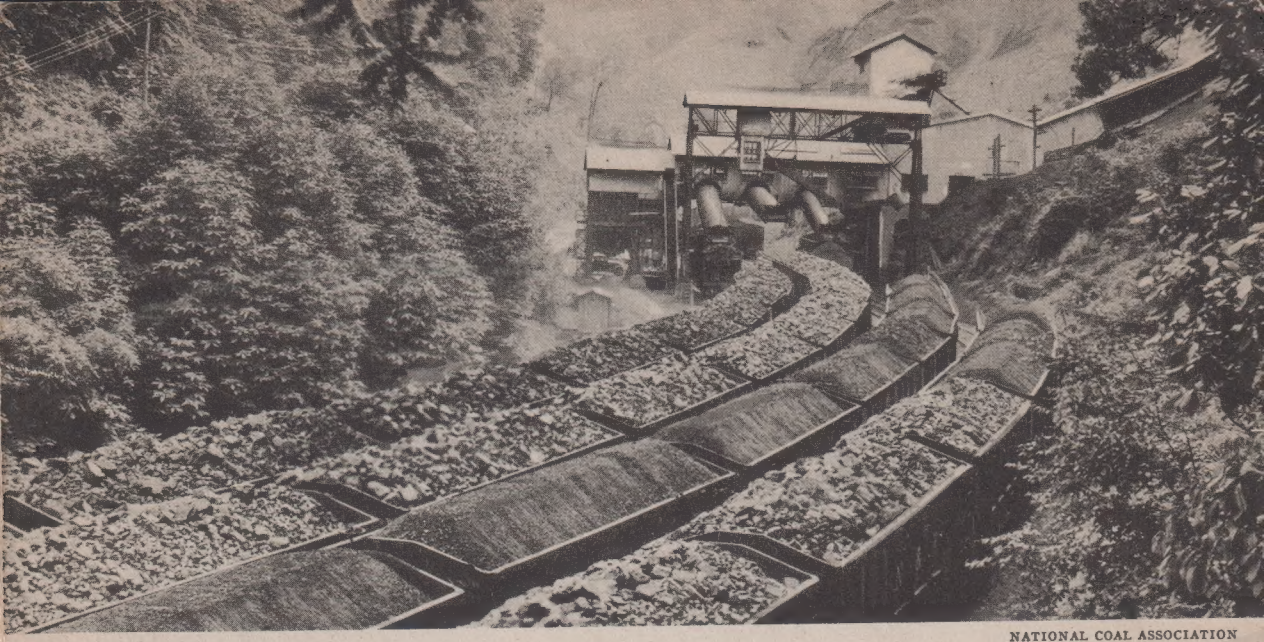
Testing perfumes made from coal tar

Then one scientist after another began to find out what could be made from these troublesome substances. It was a great mistake to think of them as worthless. Many things once very costly could be made cheaply and in plenty from these coal wastes. Let us take one example out of hundreds.

Purple was once a truly royal color. Purple dye was so costly that only the rich and great could wear things colored purple. Now anybody can wear purple. A purple dye was the first dye made from coal tar.

Not purple dyes alone, but dyes of every color of the rainbow can be made from it. Not dyes alone, but perfumes, drugs, gas for cooking, fertilizers, explosives, artificial amber, and even fine silklike stockings, and a thousand other things can be made from coal wastes. The coke-makers had been letting fortunes slip away from them into the streams and the air!

Coal has made our life richer in hundreds of ways. Ours is not a coal-forming age, but it is the greatest coal-using age the world has ever known. Ours, too, might well be called the Great Coal Age.



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Things to Do

1. Collect as many different kinds of coal as you can. Label a lump of each kind for your school museum.

2. Make a list of ten things you own which coal helped to manufacture.

3. Collect as many products of coal as you can. Moth balls, coke, ammonia water, aspirin, and coal tar dyes are some of the things you should have in your collection.

4. If you burn coal in a furnace or stove in your home, find out what kind of coal you burn.

5. Visit a coal mine if there is one near you.

6. If there is a museum near you, it may have a coal exhibit. It may even have a model coal mine that you can go down in. Go to see any such exhibit that you can.

7. Heat some small pieces of soft coal in a test tube. Notice the smoky gas that comes out of the test tube. Notice the drops of liquid that form on the walls of the test tube. Notice the coke that is left in the bottom of the test tube.

8. If you burn soft coal in your home, look for prints of leaves in the coal.